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# Global increases in kidney cancer incidence, 1973–1992

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**Reports of increasing rates for kidney cancers in several countries prompted this analysis of global incidence trends for total kidney cancers and by subsite. International incidence data for 5-year periods 1973–1977, 1978–1982, 1983–1987 and 1988–1992 were obtained from volumes IV to VII of *Cancer Incidence in Five Continents* published by the International Agency for Research on Cancer. The USA data for the same 5-year periods were obtained from the Surveillance, Epidemiology, and End Results Program of the National Cancer Institute. Percentage changes in incidence rates were computed using the relative difference between the time periods 1973–1977 and 1988–1992, and annual percentage changes in incidence rates were computed using log linear regression. In 1988–1992, kidney cancer incidence rates (age-adjusted to the world-standard population) were highest in France (16.1/100 000 man-years and 7.3/100 000 woman-years) and lowest in India (2.0 and 0.9, respectively). Between 1973–1977 and 1988–1992, incidence rates rose among men and women in all regions and ethnic groups, with a few exceptions, mostly in Scandinavian countries. The largest percentage increase for men was in Japan (171%) and for women in Italy (107%). Rates for renal pelvis cancer were less than 1/100 000 person-years in almost all regions in both sexes, and the temporal trends were inconsistent. Incidence trends for renal parenchyma cancer tracked those for total kidney cancers, and appeared to result from increases in the prevalence of risk factors and in use of diagnostic imaging procedures.** 

*Key words:* Incidence, kidney neoplasm, renal parenchyma, renal pelvis, trends.

## Introduction

Kidney cancers account for almost 2% of all cancers worldwide, with 150 000 new cases and 78 000 deaths from the disease occurring annually (Parkin *et al.*, 1999). In the USA, more than 80% of kidney cancers are renal cell carcinomas (RCC) arising from the renal parenchyma. The remainder are mainly transitional cell carcinomas originating from the renal pelvis (Chow *et al.*, 1999a). Incidence and mortality rates of kidney cancers, particularly RCC, have been reported to be rising in some countries (La Vecchia *et al.*, 1992; Liu *et al.*, 1997; Wunderlich *et al.*, 1998; Chow *et al.*, 1999b; Jin *et al.*, 1999; McCredie *et al.*, 1999), prompting this systematic survey of kidney cancer trends in selected population-based cancer registries around the world.

## Materials and methods

### *Data sources*

Incidence rates (age-adjusted to the world-standard population) for total kidney cancer (ICD 9: 189) and by kidney subsite (renal parenchyma (ICD 9 189.0). and renal pelvis (ICD 9 189.1), excluding ureter and other subsites (ICD 9 189.2–189.9)) (World Health Organization, 1977) between 1973 and 1992 were obtained from volumes IV–VII of *Cancer Incidence in Five Continents* (CI5) (Waterhouse *et al.*, 1982; Muir *et al.*, 1987; Parkin *et al.*, 1992, 1997). The CI5 included incidence data reported by selected population-based cancer registries covering areas within five continents including Asia, Oceania, Africa, Europe and the Americas. Volumes IV–VII generally provided data for 5-year time periods 1973–1977, 1978–1982, 1983–1987 and 1988–1992, respectively. Regions and ethnic populations were selected based on the availability of incidence data in the successive volumes and quality of the data, as noted in CI5 and reflected by a high percentage of cases with histological confirmation.

The USA data between 1973 and 1992 were obtained from the Surveillance, Epidemiology and End Results (SEER) program, National Cancer Institute (Ries *et al.*, 2000), since aggregate SEER data were not published in volumes IV and V of CI5.

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The SEER program included nine population-based cancer registries covering approximately 10% of the total USA population. Incidence rates for Shanghai (China) for the same time period were based on data reported by Jin *et al.* (1999), because volume IV of CI5 provided information only for the year 1975.

A total of 23 ethnic populations were identified from selected cancer registries in 20 countries, including six from Asia, two from Oceania, ten from Europe, and five from the Americas. Sufficient data were not available from Africa and hence were not included for analysis. Separate data for renal parenchyma and renal pelvis cancers were available only in 14 of the 23 regions, including the USA (SEER), Alberta, British Columbia, Cali, Denmark, Bas-Rhin, Varese, Warsaw, Geneva, South Thames, Israel (All Jews), Miyagi, Singapore (Chinese) and Bombay.

### *Data analysis*

Trends in incidence rates were examined whenever possible for the time periods 1973–1977, 1978–1982, 1983–1987 and 1988–1992. However, data for a complete 5-year period were not available in Hong Kong (1974–1977), Bombay (1974–1977), Miyagi (1978–1981), Denmark (1973–1976), Bas-Rhin (1975–1977 and 1978–1981), Varese (1976–1977 and 1978–1981), Geneva (1979–1982) and Warsaw (1980–1982 and 1989–1992). Trends in incidence rates were examined separately for renal parenchyma and renal pelvis cancers in areas where anatomic subsite data were available.

Percentage changes in rates were computed using the relative difference between the time periods 1973–1977 and 1988–1992. Annual percentage changes in rates were estimated by means of a linear regression of the logarithm of the respective rates on the mid-point of the calendar time period, weighted by the number of cases. In the regression model, $\hat{a}$, the estimated annual percentage change was derived from $[\exp(\hat{a})-1] \times 100$. This change was considered to be statistically significant at the 5% level. The software 'Origin' (MicroCal Software Inc, Northampton, Massachusetts, USA) was used to generate plots of incidence rates by time periods. Plots were prepared using a semi-log scale to facilitate the comparison of temporal trends; the scale used was such that a slope of 10 degrees indicated a change of 1% per year (Devesa *et al.*, 1995).

## Results

During 1988–1992, the incidence of kidney cancer was highest in Bas-Rhin (France) among both men and women (16.1/100 000 man-years and 7.3/100 000 woman-years) (Tables 1 and 2). Rates were generally high in Western Europe, North America and Scandinavia, intermediate in the UK and Oceania, and low in South America and Asia (except Jews in Israel). The lowest rates were in Bombay (India) (2.0/100 000 man-years and 0.9/100 000 woman-years), about one-eighth of those in France. The male:female rate ratio was highest in Varese (Italy) (2.8:1) and lowest in New South Wales (Australia) (1.5:1). The ratios were higher than 2:1 in all regions except for Colombia, Scandinavia, Oceania and China.

During the 20-year period 1973–1992, kidney cancer incidence rates rose substantially in nearly all regions (Figures 1a and 1b). Notable exceptions were Denmark and Sweden where moderate or no increases in earlier periods were followed by declines in the latest period (1988–1992), resulting in an overall decrease in incidence. Downward trends during the latest period were also observed for men in Switzerland and for women in Colombia.

The three regions with the greatest increases in kidney cancer incidence in both sexes from 1973 to 1992 were Miyagi (Japan), Varese (Italy) and Eastern States (Germany) (Tables 1 and 2). The rates per 100 000 man-years increased 171% (or 7% per year; $P = 0.01$) in Miyagi, 97% (or 5% per year; $P = 0.008$) in Varese, and 94% (or 5% per year; $P = 0.001$) in Eastern States. The rates per 100 000 woman-years increased 79% (or 4% per year; $P = 0.05$) in Miyagi, 108% (or 5% per year; $P = 0.005$) in Varese, and 84% (or 4% per year; $P = 0.002$) in Eastern States. In addition, rates increased significantly among men (95%) but not among women (43%) in Shanghai (China). More moderate but significant increases in rates were also seen among men (60%) and women (74%) in New South Wales (Australia), and among men (56%) and women (66%) in Bas-Rhin (France). The increases in other regions were all below 60%, ranging from 18% in Norway to 59% in Finland for men, and from 16% in Norway to 53% in Warsaw (Poland) for women.

Among the registries with four-digit anatomic subsite codes during 1988–1992, 80–98% of total kidney cancers originated within the renal parenchyma or renal pelvis (excluding 2–20% cancers originating in the ureter or other subsites; ICD 9 189.2–189.9). Of cancers originating in the kidney, 87–100% were renal parenchyma cancers, with the highest incidence in Bas-Rhin (France) (14.5/100 000 man-years and 6.9/100 000 woman-years) and the lowest incidence in Bombay (India) (1.8/100 000 man-years and 0.8/100 000 woman-years) (Figure 2). Over

**Table 1.** International variation in kidney cancer incidence rates[a] among males, 1973–1977 to 1988–1992

| Country | 1973–1977 | | 1988–1992 | | Percentage change[b] | EAPC[c] (wgtd) | *P*-value (wgtd) |
|---|---|---|---|---|---|---|---|
| | Count | Rate | Count | Rate | | | |
| Americas | | | | | | | |
| USA, SEER: Black | 283 | 7.9 | 639 | 12.4 | 57.0 | 3.1 | 0.003[d] |
| USA, SEER: White | 4074 | 8.8 | 6958 | 11.8 | 34.1 | 2.0 | 0.008[d] |
| Canada, Alberta | 314 | 7.3 | 754 | 11.4 | 56.2 | 3.6 | 0.083 |
| Canada, British Columbia | 487 | 7.1 | 1016 | 9.6 | 35.2 | 2.1 | 0.008[d] |
| Colombia, Cali | 31 | 2.5 | 62 | 2.5 | 0 | 0.1 | 0.800 |
| Scandinavia | | | | | | | |
| Finland | 1121 | 7.6 | 2245 | 12.1 | 59.2 | 3.3 | 0.007[d] |
| Sweden | 3509 | 11.0 | 3745 | 10.3 | −6.4 | −0.4 | 0.523 |
| Norway | 1063 | 7.6 | 1496 | 9.0 | 18.4 | 1.2 | 0.355 |
| Denmark | 1545 | 9.2 | 1761 | 8.9 | −3.3 | 0 | 0.982 |
| Other Europe | | | | | | | |
| France, Bas-Rhin | 156 | 10.3 | 439 | 16.1 | 56.3 | 3.3 | 0.053 |
| Italy, Varese | 68 | 7.7 | 424 | 15.2 | 97.4 | 4.9 | 0.008[d] |
| Germany, Eastern States | 3560 | 7.1 | 2706 | 13.8 | 94.4 | 4.6 | 0.001[d] |
| Poland, Warsaw City | 318 | 8.8 | 544 | 13.3 | 51.1 | 3.2 | 0.232 |
| Switzerland, Geneva | 104 | 10.3 | 133 | 10.0 | −2.9 | 0.1 | 0.901 |
| UK, England, South Thames | 1114 | 4.8 | 1656 | 6.5 | 35.4 | 2.1 | 0.019[d] |
| Oceania | | | | | | | |
| Australia, New South Wales | 756 | 5.8 | 1695 | 9.3 | 60.3 | 3.0 | 0.009[d] |
| New Zealand: Non-Maori | 447 | 6.1 | 679 | 7.1 | 16.4 | 0.8 | 0.498 |
| Asia | | | | | | | |
| Israel: All Jews | 537 | 7.1 | 1144 | 10.4 | 46.5 | 2.9 | 0.210 |
| Japan, Miyagi | 101 | 2.4 | 486 | 6.5 | 170.8 | 6.9 | 0.010[d] |
| Singapore: Chinese | 84 | 3.0 | 184 | 4.3 | 43.3 | 2.8 | 0.059 |
| China, Hong Kong | 221 | 3.2 | 567 | 3.8 | 18.8 | 1.7 | 0.202 |
| China, Shanghai | 196 | 1.5 | 639 | 2.9 | 95.2 | 4.8 | 0.046[d] |
| India, Bombay | 82 | 1.3 | 301 | 2.0 | 53.8 | 2.9 | 0.210 |

[a]Per 100 000 person-years, directly age-adjusted to the world standard population.
[b]Based on un-rounded rates.
[c]Estimated annual percentage change.
[d]Statistically significant at 5% level.

time, incidence trends for renal parenchyma cancers closely tracked those for total kidney cancers. The greatest increases from 1973 to 1992 were observed among both men and women in Miyagi (Japan), Varese (Italy) and Eastern States (Germany). In the USA, increases were more pronounced among blacks than whites in both sexes (data not shown).

Renal pelvis cancers accounted for 0–13% of kidney cancers across regions during 1988–1992, with incidence rates generally less than one per 100 000 person-years in both sexes, and close to zero in Costa Rica, Cali and Bombay (Figure 2). The temporal trends for renal pelvis cancers were inconsistent across regions (data not shown). In Denmark and Switzerland, renal pelvis cancer incidence rates were among the highest but have declined over time, contributing to overall decreases in kidney cancer incidence in the latest time period. In the USA, where the number of cases were larger than other registries included in this analysis and classification of subtype of kidney cancer was based on both anatomic site and histological type, incidence rates for renal pelvis cancer declined among white men and remained stable among white women and blacks (Chow *et al.*, 1999a).

## Discussion

Around the world, the incidence rates for kidney cancer have varied as much as eightfold among men and women. Rates have been high in Western Europe, North America and Scandinavia, intermediate in the UK and Oceania, and low in South America and Asia. In all regions there have been increases in rates from 1973 to 1992, except in Scandinavia where substantial increases were seen only in Finland. The upward trends are mainly limited to cancers in the renal parenchyma, nearly all of which are RCC, the most common form of kidney cancer.

It seems likely that the rising incidence of renal parenchyma cancer is due both to an increased prevalence of risk factors and to improvements in

**Table 2.** International variation in kidney cancer incidence rates[a] among females 1973–1977 to 1988–1992

| Country | 1973–1977 | | 1988–1992 | | Percentage change[b] | EAPC[c] (wgtd) | *P*-value (wgtd) |
|---|---|---|---|---|---|---|---|
| | Count | Rate | Count | Rate | | | |
| Americas | | | | | | | |
| USA, SEER: Black | 193 | 4.5 | 424 | 6.1 | 35.6 | 2.2 | 0.028[d] |
| USA, SEER: White | 2337 | 4.2 | 4184 | 5.7 | 35.7 | 2.3 | 0.042[d] |
| Canada, Alberta | 177 | 4.0 | 435 | 5.9 | 47.5 | 3.2 | 0.142 |
| Canada, British Columbia | 264 | 3.4 | 565 | 4.6 | 35.3 | 2.5 | 0.113 |
| Colombia, Cali | 30 | 1.7 | 45 | 1.5 | −11.8 | −0.4 | 0.900 |
| Scandinavia | | | | | | | |
| Finland | 928 | 4.6 | 1805 | 6.7 | 45.7 | 2.8 | 0.039[d] |
| Sweden | 2505 | 6.7 | 2764 | 6.4 | −4.5 | −0.2 | 0.409 |
| Norway | 747 | 4.5 | 1056 | 5.2 | 15.6 | 0.9 | 0.032[d] |
| Denmark | 1201 | 6.4 | 1413 | 5.7 | −10.9 | −0.5 | 0.579 |
| Other Europe | | | | | | | |
| France, Bas-Rhin | 95 | 4.4 | 266 | 7.3 | 65.9 | 3.7 | 0.015[d] |
| Italy, Varese | 31 | 2.6 | 213 | 5.4 | 107.7 | 5.3 | 0.005[d] |
| Germany, Eastern States | 2940 | 3.7 | 1974 | 6.8 | 83.8 | 4.1 | 0.002[d] |
| Poland, Warsaw City | 220 | 4.0 | 368 | 6.1 | 52.5 | 3.3 | 0.273 |
| Switzerland, Geneva | 43 | 3.2 | 85 | 4.2 | 31.3 | 1.2 | 0.410 |
| UK, England, South Thames | 689 | 2.3 | 1044 | 3.2 | 39.1 | 2.3 | 0.029[d] |
| Oceania | | | | | | | |
| Australia, New South Wales | 526 | 3.5 | 1281 | 6.1 | 74.3 | 3.7 | 0.006[d] |
| New Zealand: Non-Maori | 248 | 2.9 | 489 | 4.4 | 51.7 | 3.1 | 0.026[d] |
| Asia | | | | | | | |
| Israel: All Jews | 308 | 3.9 | 672 | 5.4 | 38.5 | 2.3 | 0.150 |
| Japan, Miyagi | 73 | 1.4 | 216 | 2.5 | 78.6 | 4.1 | 0.050[d] |
| Singapore: Chinese | 55 | 1.7 | 116 | 2.2 | 29.4 | 2.3 | 0.165 |
| China, Hong Kong | 132 | 1.6 | 378 | 2.3 | 43.8 | 2.1 | 0.066 |
| China, Shanghai | 169 | 1.2 | 371 | 1.6 | 42.6 | 2.8 | 0.069 |
| India, Bombay | 47 | 1.0 | 130 | 0.9 | −10.0 | 0.7 | 0.795 |

[a]Per 100 000 person-years, directly age-adjusted to the world standard population.
[b]Based on un-rounded rates.
[c]Estimated annual percentage change.
[d]Statistically significant at 5% level.

diagnosis. Cigarette smoking (McLaughlin *et al.*, 1995), obesity (Mellemgaard *et al.*, 1995), and hypertension (Chow *et al.*, 2000) are well-established risk factors, together accounting for nearly half of the RCCs arising in the USA population (Benichou *et al.*, 1998). *Per capita* cigarette consumption decreased in many countries from 1970 to 1990, especially in the USA, Canada, Colombia, India, Hong Kong, the UK and New Zealand, but increased in other countries, such as Norway, France, Israel, Japan and China (Corrao *et al.*, 2000). It is possible that the continuing increases in cigarette consumption in some countries, such as Japan, China and France, have contributed to the upward trends in renal parenchyma cancer; however, the correlations are not consistent across regions, perhaps due to a long latency period for cancer development and a relatively slow decline in RCC risk following smoking cessation (McLaughlin *et al.*, 1995), as well as the large variations in smoking prevalence among population subgroups in various regions.

Another important risk factor for RCC is obesity, and its increasing prevalence in many populations has probably contributed to the upward cancer trends (Statistics Canada, 1994; Popkin *et al.*, 1995; Flegal *et al.*, 1998). The impact of hypertension on time trends for renal parenchyma cancer is less clear, since its prevalence has increased in some countries (Wu *et al.*, 1995; Antikainen *et al.*, 1999), but not in others (Rosengren *et al.*, 2000). It should be noted that the prevalence of hypertension may be influenced by health care practices and prescription patterns for antihypertensive medications. In some countries where hypertension prevalence has remained stable or declined, prescription antihypertensive drug use has risen sharply (Mosterd *et al.*, 1999). In the USA, however, the more pronounced increase in RCC incidence among the black population is consistent with the higher prevalence of hypertension, which along with obesity may account for the higher incidence of RCC among blacks than whites (Chow *et al.*, 1999a).

In the USA, the largest increases in RCC occurred for early-stage tumours, suggesting an influence of diagnostic surveillance resulting from the introduction of modern imaging techniques in the

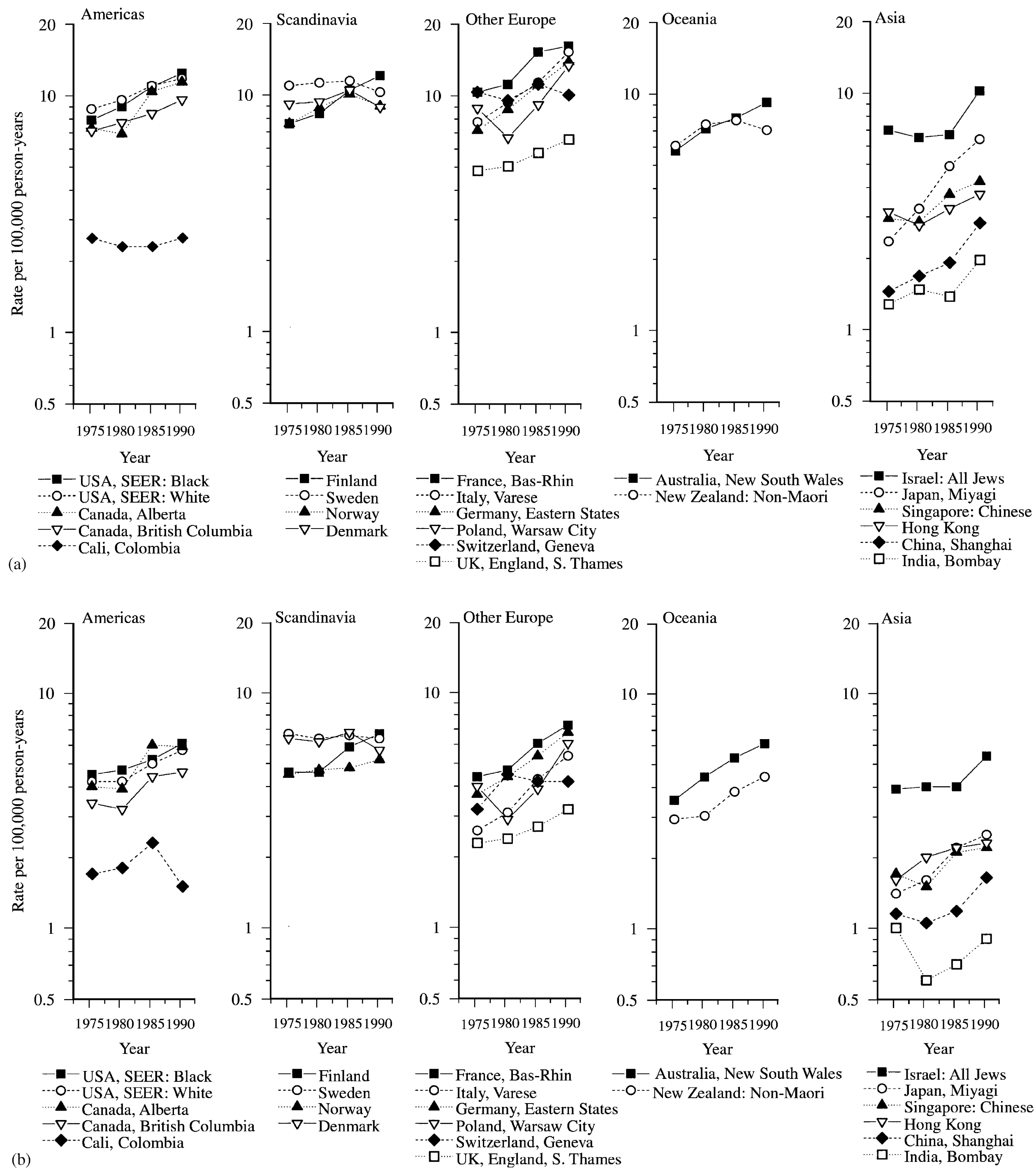


**Figure 1.** International trends in kidney cancer incidence, 1973–1992. (a) Males; (b) Females.

early 1970s, thus permitting the incidental detection of pre-symptomatic renal parenchyma tumours. However, the incidence of late-stage RCC also increased in the USA, along with mortality trends for kidney cancer, suggesting that risk factors are contributing to the upward pattern (Chow *et al.*, 1999b). Rising mortality trends of kidney cancer have also been observed in other countries, such as Japan,

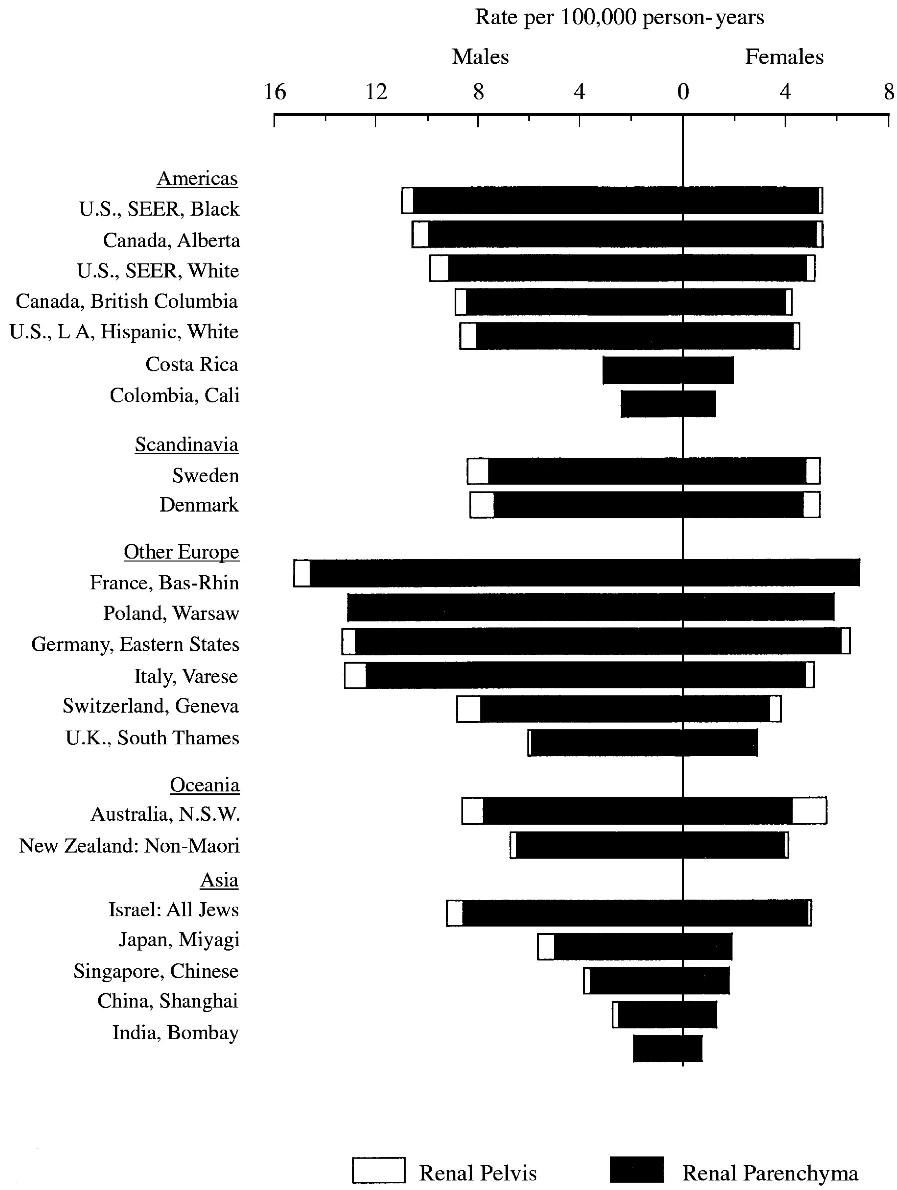


**Figure 2.** International kidney cancer incidence rates 1988–1992.

Australia, and a number of countries in Europe, indicating a real increase in this disease (La Vecchia *et al.*, 1992; McCredie 1994; McCredie *et al.*, 1999).

Reasons for the divergent trends in kidney cancer incidence in Scandinavian countries are unclear. In Denmark and Sweden, rates were generally high in 1973–1977 but declined over the study period. In contrast, rates were relatively low in Finland and Norway in the early years, but increased over time. Variations in smoking patterns may partially explain these observed patterns (from 1970 to 1990, *per capita* cigarette consumption increased 10% in Norway and 4% in Finland, but declined 4% in Denmark and Sweden (Corrao *et al.*, 2000)). Also in Sweden (Rosengren *et al.*, 2000) and Denmark (Sjol *et al.*, 1998), the prevalence of hypertension declined, while it increased in Finland (Antikainen *et al.*, 1999) from 1972 to 1992.

The kidney cancer incidence rates in Asian countries (except Israeli Jews) were lower than any other population except in Cali (Colombia). It is of interest that among persons of Chinese origin, those residing in Singapore and Hong Kong had higher rates than those in Shanghai, although the rates increased more sharply in Shanghai. These patterns appear to reflect variations in risk factors such as smoking, obesity (Popkin *et al.*, 1995) and hypertension (Wu *et al.*, 1995). It is also possible that the trend toward a more westernized diet in Asian countries (Popkin *et al.*, 1995; Koo *et al.*, 1997) plays a role, since high consumption of meat and fat has been linked to RCC risk (Chow *et al.*, 1999a).

The inconsistency in renal pelvis cancer trends across regions may be explained, in part, by differences in the misclassification of renal parenchyma and renal pelvis cancers in various registries. For instance, in the USA during the latest time period (1988–1992), 3% of tumours coded as kidney cancer NOS have transitional cell carcinomas as the cell type (World Health Organization, 1990) and should have been classified as renal pelvis cancer (Devesa *et al.*, 1990). To re-classify these tumours correctly, however, would increase the number of renal pelvis cancers by as much as 30%. These observations suggest that misclassification in subtype of kidney cancer may substantially affect the observed incidence of renal pelvis cancer, but not of renal parenchyma cancer because of its much larger number and more stable base.

In addition, variation in temporal trends of cigarette smoking and use of phenacetin-containing analgesics, well-established risk factors for renal pelvis cancers (McCredie, 1994), may have contributed to the diverse trends of this cancer across regions. The decline in renal pelvis cancer seen among white men in the USA may be due to decreases in the *per capita* cigarette consumption since the 1960s (Corrao *et al.*, 2000). Likewise, the removal of phenacetin-containing analgesics from Denmark, Switzerland and the USA since the early 1970s may have played a role in the downward renal pelvis cancer trends reported in these countries (McCredie, 1994).

Some of the potential limitations of this analysis are: (a) data for the standard 5-year time intervals were unavailable for certain regions; (b) except for Scandinavia where registries are nationwide, mostly one cancer registry was selected per country, which may not necessarily be representative of the tumour pattern for the entire country; (c) no region could be included from Africa due to lack of quality data; (d) incidence data on anatomic subsite in the successive CI5 volumes IV–VII were available in only 14 of the 23 regions studied, and histological data were not available to refine the subtype classification of kidney cancer.

In conclusion, the incidence of kidney cancer has increased substantially in all areas around the world, largely due to upward trends in renal parenchyma cancer. To some extent, the trends may be explained by increases in the incidental detection of RCC resulting from modern diagnostic imaging. In addition, the trends may partly result from the increasing prevalence of risk factors, notably obesity, although variations in hypertension, cigarette smoking, and dietary habits may have played a role in some countries.

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## References

Antikainen RL, Jousilahti P, Tuomilehto J (1999). Trends in the prevalence of isolated systolic hypertension in the middle-aged population in 1972–1992. *J Hum Hypertens* **13:** 485–91.

Benichou J, Chow WH, McLaughlin JK, *et al.* (1998). Population attributable risk of renal cell cancer in Minnesota. *Am Epidemiol* **148:** 424–30.

Chow WH, Devesa SS, Fraumeni JF Jr (1999a). Epidemiology of renal cell carcinoma. In *Comprehensive Textbook of Genitourinary Oncology* (eds Vogelzang NJ, Shipley WU, Scardino PT, Coffey DS); Lippincott Williams and Wilkins, New York, pp. 101–10.

Chow WH, Devesa SS, Warren JL, Fraumeni JF Jr (1999b). Rising incidence of renal cell cancer in the United States. *JAMA* **281:** 1628–31.

Chow WH, Gridley G, Fraumeni JF Jr, Jarvholm B (2000). Obesity, hypertension, and the risk of kidney cancer in men. *N Engl J Med* **343:** 1305–11.

Corrao MA, Guindon GE, Sharma N, Shokoohi DF (2000). *Tobacco Control Country Profiles*. American Cancer Society, Atlanta, GA.

Devesa SS, Donaldson J, Fears T (1995). Graphical presentation of trends in rates. *Am J Epidemiol* **141:** 300–4.

Devesa SS, Silverman DT, McLaughlin JK, *et al.* (1990). Comparison of the descriptive epidemiology of urinary tract cancers. *Cancer Causes Control* **1:** 133–41.

Flegal KM, Carroll MD, Kuczmarski RJ, Johnson CL (1998). Overweight and obesity in the United States: prevalence and trends, 1960–1994. *Int J Obesity* **22:** 39–47.

Jin F, Devesa SS, Chow WH, *et al.* (1999). Cancer incidence trends in urban Shanghai, 1972–1994: an update. *Int J Cancer* **83:** 435–40.

Koo LC, Mang OWK, Ho JHC (1997). An ecological study of trends in cancer incidence and dietary changes in Hong Kong. *Nutr Cancer* **28:** 289–301.

La Vecchia C, Levi F, Lucchini F, Negri E (1992). Descriptive epidemiology of kidney cancer in Europe. *J Nephrol* **5:** 37–43.

Liu S, Semenciw R, Morrison H, *et al.* (1997). Kidney cancer in Canada: the rapidly increasing incidence of adenocarcinoma in adults and seniors. *Can J Public Health* **8:** 99–104.

McCredie M (1994). Bladder and kidney cancers. In *Trends in Cancer Incidence and Mortality* (eds Doll R, Fraumeni JF Jr, Muir CS); Cold Spring Harbor Laboratory Press, Cancer Surveys 19/20, pp. 343–68.

McCredie M, Stewart J, Supramaniam R, Williams S (1999). Observations on the effect of abolishing analgesic abuse and reducing smoking on cancers of the kidney and bladder in New South Wales, Australia, 1972–1995. *Cancer Causes Control* **10:** 303–11.

McLaughlin JK, Lindblad P, Mellemgaard A, *et al.* (1995). International renal-cell cancer study. I. Tobacco use. *Int J Cancer* **60:** 194–8.

Mellemgaard A, Lindblad P, Schlehofer B, *et al.* (1995). International renal-cell cancer study. III. Role of weight, height, physical activity, and use of amphetamines. *Int J Cancer* **60:** 350–4.

Mosterd A, D'Agostino RB, Silbershatz H, *et al.* (1999). Trends in the prevalence of hypertension, antihypertensive therapy, and left ventricular hypertrophy from 1950 to 1989. *N Engl J Med* **340:** 1221–7.

Muir C, Waterhouse J, Mack T, Powell J, Whelan S (1987). *Cancer Incidence in Five Continents*, Vol V. IARC Scientific Publication No. 88. International Agency for Research on Cancer, Lyon.

Parkin DM, Muir CS, Whelan SL, *et al.* (1992). *Cancer Incidence in Five Continents*, Vol VI. IARC Scientific Publication No. 120. International Agency for Research on Cancer, Lyon.

Parkin DM, Whelan SL, Ferlay J, Raymond L, Young J (1997). *Cancer Incidence in Five Continents*, Vol VII. IARC Scientific Publication No. 143. International Agency for Research on Cancer, Lyon.

Parkin DM, Pisani P, Ferlay J (1999). Global cancer statistics. *CA Cancer J Clin* **49:** 33–64.

Popkin BM, Paeratakul S, Ge K, Zhai F (1995). Body weight patterns among the Chinese: results from the 1989 and 1991 China health and nutrition surveys. *Am J Public Health* **85:** 690–4.

Ries LA, Eisner MP, Kosary CL, *et al.* (2000). *SEER Cancer Statistics Review,* 1973–1997. National Cancer Institute, Bethesda, MD.

Rosengren A, Eriksson H, Larsson B, *et al.* (2000). Secular changes in cardiovascular risk factors over 30 years in Swedish men born in 1913, 1923, 1933 and 1943. *J Intern Med* **247:** 111–18.

Sjol A, Thomsen KK, Schroll M (1998). Secular trends in blood pressure levels in Denmark 1964–1991. *Int Epidemiol Assoc* **27:** 614–22.

Statistics Canada (1994). *Health Status of Canadians: Report of the 1991 General Social Survey*. Ottawa, Canada.

Waterhouse J, Muir C, Shanmugaratnam K, Powell J (1982). *Cancer Incidence in Five Continents*, Vol IV. IARC Scientific Publication No. 42. International Agency for Research on Cancer, Lyon.

World Health Organization (1977). *Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death*. WHO, Geneva.

World Health Organization (1990). *International Classification of Diseases for Oncology (ICD-O)*, 2nd edn. WHO, Geneva.

Wu X, Duan X, Gu D, *et al.* (1995). Prevalence of hypertension and its trends in Chinese populations. *Int J Cardiol* **52:** 39–44.

Wunderlich H, Schumann S, Jantitzky V, *et al.* (1998). Increase of renal cell carcinoma incidence in central Europe. *Eur Urol* **33:** 538–41.